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(54) Device for changing the control angle between a machine part and a driving unit controlling it.

The device serves to change the control angle between a machine part (1), preferably with linearly adjustable control and moving back and forth periodically, in this particular case the valve body of the intake and/or discharge valve of an internal combustion engine, and a driving unit controlling the machine part (1). The adjustment of the control angle occurs as a variation of the operating conditions, such as e.g. the RPM of the driving unit, with the machine part (1) being held by a guide part (3) that is guided in the direction of the movements of the machine part and that interlocks positively with the driving unit (2). The machine part (1) can execute a regulating motion against the guide part in the direction of its movements, the regulating motions being restricted on both sides and attenuated through attenuation agents, to which effect two chambers (6, 7) are formed between the machine part and the guide part (1, 3); the chambers of variable dimensions are connected with each other by at least one flow channel and filled with the attenuation agent. The dimensions of the chambers (6, 7) are determined by each axial position of the machine part (1) against the guide part and change together with it in opposite directions.

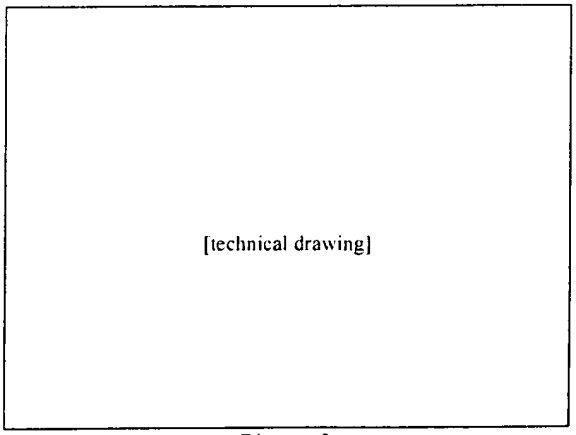

Diagram 2

1

Description

The invention concerns a device to change the control angle between a machine part (1), preferably with linearly adjustable control and moving back and forth periodically, in this particular case the valve body of the intake and/or discharge valve of an internal combustion engine, and a driving unit controlling the machine part (1), with the adjustment of the control angle occurring as a variation of the operating conditions, such as e.g. the RPM of the driving unit and with the machine part (1) being held by a guide part (3) that is guided in the direction of the movements of the machine part and that interlocks positively with the driving unit (2).

A device of this type that is known from the not pre-published patent registration P 37 06 187 serves as part of the valve control of four-stroke Otto engines and diesel engines to vary the time profiles of the intake and/or discharge valves as a variation of the operating conditions of the engine, resulting in various advantages, among others decreased fuel consumption in the low-speed range of an engine that has already been optimized thermodynamically. Such valve controls that are known from the aforementioned patent registration may be up to the mark, but they are relatively expensive mechanically and therefore cost intensive in their manufacture.

The invention is based on the objective of developing a device of the type mentioned at the beginning in such a way that a simple and thus cost-effective and safe-to-operate design is attained.

This objective is solved in accordance with the invention by allowing the machine part to execute a regulating motion against the guide part in the direction of its movement that is axially restricted on both sides and that is attenuated by an attenuation agent, to which end two chambers of variable dimensions filled with the attenuation agent and connected by at least one flow channel are formed between the machine part and the guiding part, with the dimensions being determined by each axial position of the machine part against the guide part, and changing together with it in opposite directions.

Initially, the advantage obtained by the invention consists of the fact that at high RPM, i.e. with a fast oscillating machine part, the attenuation agent can flow through the flow channel or channels only to an extremely limited degree, with the machine part following immediately the driving unit that operates it. At low RPM or, respectively, stroke frequencies of the machine part, the machine part can be influenced in its sequence of movements, in particular through a force acting upon the machine part, resulting in a sequence of movements with a phase shift against the driving unit. If for example the machine part is the valve body of the discharge valve of an internal combustion engine, the compression pressure as well as the mass inertia can lead to a delayed opening of the valve that is desired at low RPM. This corresponds to an automatic readjustment of the closing angle. The regulating motion also automatically compensates for any temperature-caused longitudinal changes, with the attenuating agent flowing from one chamber into the other until a balance of forces occurs in the sense of an integration in the long-term average. Furthermore, the length of the stroke distance is adjusted in accordance with the amount of attenuating agent flowing through the flow channels with each stroke. Thus, the stroke distance decreases with increased diminution of the closing angle.

In a preferred model version of the invention the two chambers are formed by a common ring groove at the machine part and a ring flange protruding from the guiding part into the ring groove, with the width of the ring flange measured in the axial direction of the machine part being smaller than the width of the ring groove by at least the width of the two chambers. To this end, the ring groove can either be positioned directly in the machine part or, in accordance with a preferred model version of the invention, in a sleeve part that is arranged in such a way that it can be adjusted and locked in place by a screw thread on the shaft of the machine part in the latter's direction of movement. This results in the additional advantage that the position of the ring groove on the shaft of the machine part can be easily changed by twisting the sleeve part. In this context, it is advantageous, in particular for the purpose of a simplified assembly, if in the area of the ring groove the sleeve part is divided in two, perpendicular to its axis. In addition, through mutual countering of the two sections of the sleeve part, no additional fastening measures will be required in order to fix the sleeve part in its assigned position on the machine part.

In order to obtain a sliding guidance of the sleeve part as well as a sealing of the chambers, receptacle grooves are provided in the sleeve part on both sides of the ring groove for sealing rings that provide a seal against the ring area enclosing the sleeve part. Accordingly, it is advisable to provide ring-shaped receptacle grooves for sealing rings, one in the area of the ring groove, or one each on either side of the dividing plane of the sleeve part.

In order to be able to affect the sequence of movements in both directions of movement, it is advantageous if at least one separate flow channel is provided with a hydraulic valve for the regulating motion of the machine part against the guiding part in each of the directions of movement. To this end, the hydraulic valves are arranged in such a way that the attenuating agent flows through the flow channels alternately in accordance with the direction of movement of the machine part. In this context it is furthermore advantageous if the valve body of the hydraulic valve is formed by a straight pin located in the flow channel with a cross-section area lower than that of the channel and a sealing surface that radially expands in conical shape on the end side and that is adjacent to a corresponding valve seat in the shape of a truncated cone, with the flow channel extending in an axial direction through the ring flange of the guiding part and the lateral walls of the ring groove of the machine part or, respectively, of the sleeve part, forming a catch for the valve body that is lifted off the valve seat. Incidentally, this allows the channels to have a relatively large diameter, thereby making them relatively easy to manufacture since the flow rate of the attenuating agent is determined by the ring crevice formed between the surface area of the flow channel and the valve body. The size of this ring crevice can be easily altered by exchanging the valve body.

Frequently it is desired to spin the machine part continually around its longitudinal axis which is particularly recommended when it involves the valve of a combustion engine. The spinning motion can be achieved within the framework of the invention in an advantageous manner by not placing the flow channels that conduct attenuating agents in one direction or the other, depending on the regulating motion, in diametrically opposed positions with regard to the longitudinal axis of the machine part. This results in an unsymmetrical, or uneven, circulation of the attenuation agent with regard to the rotational axis which exerts a corresponding torque upon the machine part.

The guiding part is guided on at least one guiding column that is provided with a coaxial cylindrical bore hole and a transversal bore hole branching off from it which is followed by a feed line to feed the chambers with the attenuating agent that ends in the region of the inner surface area of the ring flange. Each motion of the guiding part

along the guiding column creates only a brief connection between the transversal bore hole and the feed line that, however, suffices in practice. If the machine part is the valve of a combustion engine it is recommended to arrange the transversal bore and the feed line in such a way that they are flush to each other during the closed position of the valve since that is when the longest dwell time occurs. However, the transversal bore may end in a groove that extends in an axial direction of the guiding column and that is open to the latter's lateral area which allows a continual feeding of the chambers with the attenuating agent.

In another execution form of the invention, a cylinder space branches off from the feed line that is essentially perpendicular to one of the flow channels and that is connected therewith, inside of which a control piston is adjustable against the force of a coil spring that is arranged in the cylindrical space as well, with the control piston being provided with a ring groove by means of which the flow of the attenuating agent is throttled, depending on the position of the control piston. In this manner, the effective cross section area of the channels can be affected through the pressure of the attenuating agent being supplied from outside so that even during operation a supplementary effect on the operating parameters will be possible.

The guiding part may be equipped with two rollers placed at a mutual distance between which a control rib reels off that protrudes from a curve disc of the driving unit, with one of the guiding columns being equipped with a coaxial cylindrical bore hole and a transversal bore hole branching off therefrom which connects to a lubricating channel in the guiding part that ends in the area of the bearing surface of the rollers.

In the following, the invention is explained in detail by way of a model example shown in the drawing; shown are:

in **Diagram 1** the object according to the invention in four different operating states that are essentially shown schematically,

in **Diagram 2** a detailed representation of the object according to Diagram 1,

in **Diagram 3** the object according to Diagram 2, however in a slightly different version,

in **Diagram 4** in partial diagrams a) through d) the guiding part in varying representations,

in **Diagram 5** a representation corresponding to Diagram 4 of an additional version of the guiding part.

The device shown in the drawing serves to alter the control angle between a machine part 1 that is preferably guided in linearly adjustable fashion and that moves back and forth periodically, and a driving unit 2 activating the machine part 1. In this version the machine part 1 is formed by a valve body of the intake and/or discharge valve of a combustion engine as shown in the schematic representation in Diagram 1. The adjustment of the control angle is to occur as a function of the operating conditions, i.e., for example, the RPM of the driving unit, which is something strived for in the case of combustion engines.

The machine part 1 is held by a guiding part 3 that is guided adjustably in the direction of the movement of the machine part 1 and that interlocks with the driving unit 2. The machine part can execute a regulating motion that is axially limited on both sides in the direction of its movement against the guiding part, which motion is attenuated by an attenuating agent. To this end two chambers 6, 7 filled with the attenuating agent and connected via flow channels 4, 5 are formed between the machine part and the guiding part 1, 3. These chambers are variable in their dimensions that are determined by each axial position of the machine part against the guiding part 3 and that change together with it in opposite directions.

The two chambers 6, 7 are formed by a common ring groove 8 on the machine part and a ring flange protruding from the guiding part 3 into the ring groove 8. The width of the ring flange 9 measured in the axial direction of the machine part is smaller than the width of the ring groove 8 by at least the width of both chambers 6, 7.

As shown in **Diagram 2**, the ring groove *S* is provided in a sleeve part 10 that is arranged on the shaft 1.1 of the machine part 1 and that can be adjusted and locked in position in its direction of movement by means of a screw thread 11. In order to facilitate an easy assembly, the sleeve part 10 is divided in two parts in the area of the ring groove 8 in a direction perpendicular to its axis. The two halves of the sleeve part can therefore be arranged at will on the shaft 1.1 of the machine part 1 and mutually countered in their desired positions. In the sleeve part 10, on both sides of the ring groove, ring-shaped receptacle grooves 13 are provided for sealing rings 14 that provide a seal against the ring surface of the guiding part 3 surrounding the sleeve part 10. These sealing rings 14 close off the chambers 6, 7 from the outside, on the one hand, and furthermore improve the guidance of the machine part 1. In addition, one ring-shaped receptacle groove 15 is provided in the area of the ring groove 8, or one each on either side of the separation plane of the sleeve part 10, for additional sealing rings 16 that provide a mutual seal for the two chambers 6, 7.

For each of the two directions of movement of the machine part 1 a separate flow channel 4 and 5 is provided with a hydraulic valve for its regulating motion against the guiding part 3 in accordance with Diagram 2. The valve body 17 of the hydraulic valve is formed by a cylindrical pin located in the flow channel 4,5, with a smaller cross section surface than the latter. The ring crevice appearing between the valve body 17 and the surface area of the flow channel 4 determines the cross section surface effective for the flow of the attenuating agent which can be easily adjusted by exchanging the valve bodies 17. The valve body 17 is provided at its end with a sealing surface 18 that expands radially in cone-shaped fashion and which sits close to a corresponding valve seat in the shape of a truncated clone in the sleeve part 10. The flow channel 4, 5 extends in an axial direction through the ring flange 9 of the guiding part 3, with the lateral walls of the ring groove *S* of the machine part 1 or, respectively, of the sleeve part 10 forming a stop-motion device for the valve body 17 that has been lifted off the valve seat.

The flow channels 4, 5 conducting attenuating agents in one direction or the other, depending on the regulating motion, are not diametrically opposed to each other with regard to the longitudinal axis of the machine part 1 as indicated in Diagram 4. This results in an unsymmetrical flow of the attenuating agent with regard to the longitudinal axis of the machine part which leads to a torque that rotates the machine part 1 around its axis. This effect is desired in the case of valve bodies of a combustion engine to achieve a uniform burning-off at the valve disc.

The guiding part 3 is guided along two guiding columns 19, one of which is provided with a coaxial cylindrical bore hole 20 and a transversal bore hole 21 branching off from it. The transversal bore hole 21 connects to a feed line 22 that ends in the region of the inner lateral area of the ring groove 9. The feed line 22 is arranged in such a way that it lies flush with the transversal bore hole 21 in the position of the machine part 1 during which the dwell time is the longest. However, there is also the possibility shown in Diagram 5 that the transversal bore hole 21 ends in a groove 19 extending in an axial direction of the guiding column 19 that is open towards its lateral area, with the feed line 22 being connected to the transversal bore hole 21, independent of each position of the guiding part 3.

In Diagram 5 an additional possibility is shown that allows an adjustment of the effective cross section area of the flow channels 4, 5 and thus of the control angle. To this end a cylinder space 24 branching off from the feed line 22 is provided that essentially runs perpendicularly to one of the flow channels 4, 5 and that is connected to it. In this cylinder space 24 there is a control piston 25 that is adjustable against the force of a helical spring 26 that is also arranged in the cylinder space. The control piston is provided with a ring groove 25.1 through which the attenuating agent flowing in the flow channel 5 can move in conjunction with the corresponding position of the control piston 25. Through a corresponding axial adjustment of the control piston it will then be possible to throttle the flow of the attenuating agent in the flow channel 4, 5 or to block it completely, by means of which a simple additional effect can be achieved on the dynamic properties of the device during its operation.

As Diagram 1 shows in particular, the guiding part 3 features two rollers 27 arranged at a mutual distance between which a control rib 28 reels off that protrudes from a curve disc of the driving unit 2. In order to continually lubricate the rollers 27 during operation, it is intended according to Diagram 5 to provide one of the guiding columns 19 with a coaxial cylindrical bore hole 28 and a transversal bore hole 29 branching off therefrom. This transversal bore hole 29 connects to a lubricant channel 30 in the guiding part 3 that ends in the area of the bearing surface of the rollers 27.

The individual operating phases of the device are clearly shown in Diagram 1. Partial diagrams a) and b) show that the valve disc – at low RPM – initially does not lift off from the valve seat in spite of a corresponding motion of the guiding part 3 against the compression pressure in the interior of the cylinder which is not shown in detail but that the valve shaft carries out a regulating motion against the guiding part. In partial diagram c) the guiding part 3 is in its lower extreme position with the effect that the valve disc is lifted off the valve seat as well. Partial diagram d) finally demonstrates that the valve closes again prematurely due to the regulating motion and that after an additional regulating motion of the machine part 1 the position shown in partial diagram a) is reached again. As a result, an extended closing time of the valve is achieved at low RPM which is a desired effect in the practice of combustion engines. At high RPM, on the other hand, the attenuating agent can not flow with sufficient speed through the flow channel 4, 5 between the two chambers 6, 7, with the effect that then the valve disc essentially follows the movement of the guiding part.

Patent Claims

1. Device to change the control angle between a machine part (1), preferably with linearly adjustable control and moving back and forth periodically, in this particular case the valve body of the intake and/or discharge valve of an internal combustion engine, and a driving unit controlling the machine part (1), with the adjustment of the control angle occurring as a variation of the operating conditions, such as e.g. the RPM of the driving unit and with the machine part (1) being held by a guide part (3) that is guided in the direction of the movements of the machine part and that interlocks positively with the driving unit (2), characterized by the fact that the machine part (1) can execute against the guiding part (3) a regulating motion in the direction of its movement that is axially limited on both sides, which motion is attenuated by attenuating agents, to which end two chambers (6, 7) filled with the attenuating agent are formed between the machine part and the guiding part (1, 3) that are connected by at least one flow channel (4, 5) and that are variable in their dimensions, with the dimensions being determined by each axial position of the machine part (1) against the guiding part (3) and changing together with it in opposite directions.

2. Device in accordance with claim 1, characterized by the fact that the two chambers (6, 7) are formed by a common ring groove (8) on the machine part and a ring flange (9) protruding from the guiding part (3) into the ring groove, with the width of the ring flange (9) measured in the axial direction of the machine part (1) being smaller than the width of the ring groove (8) by at the least the width of the two chambers (6, 7).

3. Device according to claim 2 characterized by the fact that the ring groove (8) is provided in a sleeve part (10) that is arranged on the shaft of the machine part (1) where it can be adjusted and locked in position in the latter's direction of movement by means of a screw thread (11).

4. Device in accordance with claim 3 characterized by the fact that the sleeve part (10) is divided into two parts in the area of the ring groove in a direction perpendicular to its axis.

5. Device according to claim 3 or 4 characterized by the fact that ring-shaped receptacle grooves (13) are provided in the sleeve part (10) on both sides of the ring groove for sealing rings (14) that provide a seal against the ring surface that envelopes the sleeve part (10).

6. Device in accordance with one of claims 3 through 5 characterized by the fact that one ring-shaped receptacle groove (15) is provided for sealing rings (16) in the area of the ring groove (8), or one each on either side of the separation plane (12) of the sleeve part.

7. Device in accordance with claims 1 through 6 characterized by the fact that at least one separate flow channel (4, 5) with a hydraulic seal is provided for the regulating motion of the machine part (1) against the guiding part (3) in each of the two directions of movement.

8. Device in accordance with claim 7 characterized by the fact that the valve body (17) of the hydraulic valve is formed by a cylinder pin located in the flow channel (4, 5) with a cross section surface smaller than that of the latter, and a sealing surface (18) that widens radially in cone-shaped fashion at its end and which sits close to a corresponding valve seat shaped like a truncated cone, with the flow channel (4, 5) extending in axial direction through the ring groove (9) of the guiding part (3) and the lateral walls of the ring groove (8) of the machine part (1) or, respectively, of the sleeve part (10) forming a stop-motion device for the valve body (17) that has been lifted off the valve seat.

9. Device in accordance with claim 7 or 8 characterized by the fact that the flow channels (4, 5) carrying attenuating agents in one direction or the other, depending on the regulating motion, do not oppose each other diametrically with regard to the longitudinal axis of the machine part (3).

10. Device in accordance with claims 1 through 9 characterized by the fact that the guiding part (3) is guided on at least one guiding column (19) that is provided with a coaxial cylindrical bore hole (2) and a transversal bore hole branching off (21) therefrom that are connected to a feed line (22) feeding (6, 7) the chambers with attenuating agents and that end in the inner surface area of the ring flange (9).

11. Device in accordance with claim 10 characterized by the fact that that the transversal bore hole ends in a groove (23) that extends in an axial direction of the guiding column (19) and that is open towards to its lateral area.

12. Device in accordance with claim 11 characterized by the fact that a cylinder space (24) branches off from the feed line (22) that runs essentially perpendicular to one of the flow channels (4, 5) and that is connected to them, and in which a control piston (25) is adjustable against the force of a helical spring (26) that is arranged in the cylinder space (24) as well, with the control piston being equipped with a ring groove

(25.1) through which the flow of the attenuating agent in the flow channel (4, 5) is throttled, depending on the position of the control piston (25).

13. Device in accordance with one of claims 10 through 12 characterized by the fact that the guiding part (3) is equipped with two rollers arranged at a mutual distance between which a control rib (28) reels off that protrudes from a curve disc of the driving unit (2), and that one of the guiding columns (19) is equipped with a coaxial cylindrical bore hole (28) and a transversal bore hole (29) branching off therefrom that connects to a lubricating agent channel (3) that ends in the area of the bearing surface of the rollers (27).